

**ATTACHMENT 2**

**Peach Bottom Atomic Power Station  
Units 2 and 3  
Docket Nos. 50-277 and 50-278**

**License Amendment Request  
Revise LPRM Calibration Interval**

**Global Nuclear Fuel Report 0000-0079-0736-NP  
Exelon Nuclear LPRM Calibration Interval Increase  
for Peach Bottom Atomic Power Station, Units 2 and 3**

**Non-Proprietary Version**



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A Joint Venture of GE, Toshiba, & Hitachi

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Exelon Nuclear  
LPRM Calibration Interval Increase for  
Peach Bottom Atomic Power Station, Units 2 and 3

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## Summary

This report provides the basis for application of an LPRM calibration interval of up to 2000 effective full power hours (EFPH). The report identifies the extended calibration interval as being within the qualification basis of the core monitoring system (3DMONICORE™) for the Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3. The qualification bases for the thermal limits calculations were reviewed for MCPR, MAPLHGR and LHGR.

The impact of an increase in the LPRM calibration to 2000 EFPH has been included in the qualification of the 3DMONICORE™ core monitoring system in use at the Peach Bottom Atomic Power Station units. For PBAPS, an interval of 2000 EFPH is equivalent to 2000 Megawatt Days per short ton (MWD/st) of core exposure. The safety and licensing analyses are consistent with the power uncertainty of the core monitoring system, and these have been reviewed and approved by the USNRC. Therefore, operation with the LPRM calibration interval up to 2000 EFPH is justified using the existing safety evaluations.

An examination of Reference 1 was performed to determine whether the analyses performed by Exelon were consistent with the methodology of the GEH/GNF qualification bases.

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## **1. Introduction**

This report describes the basis for application of the capability to operate with an LPRM calibration interval of up to 2000 effective full power hours (EFPH). This capability is within the qualification basis of the core monitoring system 3DMONICORE™ for the Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3. The qualification bases for the thermal limits calculations were reviewed for MCPR, MAPLHGR and LHGR. The qualification bases for calculation of these thermal limits has included the specific uncertainties associated with an LPRM calibration interval up to 2000 EFPH. Therefore, operation with the LPRM calibration interval up to 2000 EFPH is justified using the existing safety evaluations. For PBAPS, an interval of 2000 EFPH is equivalent to 2000 Megawatt Days per short ton (MWD/st) of core exposure.

## **2. Scope of Evaluation**

GE Hitachi Nuclear Energy (GEH)/Global Nuclear Fuel (GNF) has previously justified an LPRM calibration interval up to 2000 EFPH by comparing core monitoring predictions before and after periodic LPRM calibration. These comparisons and other prediction uncertainty studies have been periodically documented for review and approval by the USNRC. This evaluation involves a review of the GEH/GNF documentation provided to and approved by the USNRC in support of core monitoring accuracy requirements. The GNF core monitoring system 3DMONICORE™, used at PBAPS, includes provision for an LPRM calibration interval up to 2000 EFPH, as well as equipment failure. The following Section 3.0 documents the approach taken for this review and Section 4.0 documents the details of the core monitoring qualification basis. Section 5.0 reports the review of the Exelon evaluation of the proposed change.

## **3. Evaluation Basis and Assumptions**

The increase in the LPRM calibration interval impacts primarily the core monitoring system calculation of fuel thermal margins. The acceptability of an increase in the LPRM calibration interval is dependent upon the accuracy of the prediction of power distribution. Therefore, the case is made in Section 4 that the increased LPRM calibration interval has been accounted for in the power uncertainty applied in the safety and licensing analyses.

## **4. Evaluation of LPRM Calibration**

This evaluation includes a review of the bundle and nodal power uncertainty of the core monitoring system and the impact of the LPRM calibration interval. The reference documents that have been used in the review of the power predictions with the USNRC are also identified.

### **4.1 MCPR Power Uncertainty**

GEH/GNF has performed detailed analyses (References 2 to 7) of power uncertainties in the core monitoring system. These analyses include model uncertainties and instrument update uncertainties. Since the inception of 3DMONICORE™, an LPRM calibration

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interval up to 2000 EFPH and a single Traversing-Incore-Probe (TIP) machine Out-Of-Service (OOS) has been included in these analyses.

Specifically, for the 3DMONICORE™ system currently used at PBAPS, the power distribution uncertainties are as follows for 2000 EFPH operation:

Table 1 (Ref. 6, Table 4.2)

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It should be noted that the table above is taken in its entirety from Reference 6. For details of the analyses and sources, the reference should be examined. Since the reference was approved in 1999, additional information has been analyzed and presented to the NRC as part of the ongoing Methods benchmarking. Reference 8 provides an example of this, addressing the 10x10 tracking. The tracking data for 10x10 fuel has been analyzed and confirms the validity of the total bundle power uncertainty given in the table.

Therefore, it is concluded that PBAPS can be operated within the Power Distribution Uncertainties for Safety Limit MCPR (Ref. 6) with 3DMONICORE™ for 2000 EFPH without running a full TIP set and calibrating LPRMs, and with one TIP machine OOS indefinitely.

The 3DMONICORE™ methods and methods uncertainties have been reviewed and approved by the Nuclear Regulatory Commission (Ref. 6). "Uncertainty due to LPRM Updates and Instrument Failure" addresses both the LPRM Calibration Interval and

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failure of one TIP machine (up to [ ]). The maximum RMS difference in bundle power due to missing TIP data with 2000 EFPH calibration interval is [ ] as is found in Table 1 and is used as the uncertainty allowance for missing TIP data. It should be noted that this determination of 3DMONICORE™ bundle power uncertainties is not dependent on the evaluation of the SLMCPR, although the approved methodology for cycle-specific SLMCPR utilizes these uncertainties.

Clearly, from the analyses performed in Reference 6 above, the qualification basis for monitoring MCPR includes the 2000 EFPH calibration interval. The Reference 7 document shows that the qualification for the latest core physics methods remains the same as for the previous evaluations.

#### **4.2 LHGR and MAPLHGR Power Uncertainty**

The NRC requested additional information and the GEH responses that were provided are included as appendices in the NRC acceptance of the Licensing Topical Report (Ref. 6). In these appendices, the NRC requested an uncertainty analysis for the 3DMONICORE™ prediction of peak kW/ft and MAPLHGR. In response, an analysis was performed then documented in Appendix A and later updated in Appendix B. The analysis continued to use the [ ] uncertainty allowance for missing TIP data. This [ ] is included in the [ ]. In this appendix, the LPRM update uncertainty on LHGR is shown to be [ ]. The nodal uncertainty derived was [ ] and the total LHGR uncertainty, which included the additional peaking uncertainty [ ].

The power distribution uncertainty allowance for thermal-mechanical analysis is [ ] for LHGR. The [ ] uncertainty includes the LPRM update uncertainty derived in the approved licensing report and is well within this allowance. The variability in MAPLHGR would be less than for LHGR because of the exclusion of the local peaking uncertainty. With this in mind, it is confirmed that the uncertainties for LPRM updates of 2000 EFPH intervals or less are acceptable within the qualification basis.

#### **4.3 Calibration Of LPRMs**

Reference 6, Section 4, analyzed the effects on operation of TIP and LPRM failures. The analyses performed included the effects on LPRM calibration with a single TIP OOS. Again, the approved NRC topical used the missing TIP data uncertainty in the stack-up for the LPRM update uncertainty.

The calibration with missing TIP information will be performed differently for those LPRMs that do not have TIP-supplied data. Basically, the planar average adaption correction term (which is applied to the [ ]) will be applied based on the TIP strings that are present. However, this update of the LPRM calibration has been taken into account in the references and the currently approved uncertainties already have the TIP OOS included.

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#### **4.4 LPRM Gain Adjustment Factor**

The recommended acceptance range for LPRM Gain Adjustment Factors (GAFs) following amplifier calibration is 1.00 +/- 0.15. The LPRM system also provides neutron flux signal inputs to the Average Power Range Monitor (APRM) system, Oscillation Power Range Monitor (OPRM) system, and the Rod Block Monitor (RBM) system, in addition to the 3D MONICORE core monitoring system. The APRM system provides indication of core average thermal power and input to the Reactor Protection System (RPS). The OPRM system is capable of detecting thermal-hydraulic instability by monitoring the local neutron flux within the reactor core. It also provides input to the RPS. The RBM system prevents the withdrawal of selected control rods when local power is above a preset limit. LPRM inputs to the 3D MONICORE system are used to calculate core power distribution and ensure operation within established fuel thermal operating limits.

The APRM readings are maintained within +/- 2% of core thermal power by calibration against weekly heat balance calculations. The core monitoring system corrects the value of LPRM reading used in the thermal limits calculation for burnup induced sensitivities. Because the LPRM chamber responses are very linear over the interval involved, the LPRM interval extension and the GAF range have an insignificant effect on the APRM accuracy during the power maneuvers or transients between LPRM calibrations. When a rod is selected, the RBM channel readings are automatically calibrated against an APRM reading and the rod block trips are set to a percentage, corresponding to the safety analysis, of the calibrated reading. Again, because LPRM chamber responses are very linear over the interval involved, the RBM system response during rod withdrawal is not significantly affected.

### **5. Review of the Exelon Evaluation of Proposed Changes**

Reference 1 is the evaluation provided by Exelon in support of the proposed change in LPRM calibration interval to 2000 EFPH. A review of the document and the follow-up RAIs and responses was performed by GNF.

Reference 1 stated the interval as being 2000 MWD/st. The follow-up responses to the NRC RAIs shows that although the 2000 EFPH is not exactly the same as 2000 MWD/st, Exelon showed that they are equivalent and Exelon addressed the exact conversion.

Additionally, in the follow-up responses to the NRC RAIs, an examination was made for the Technical Specification allowance of 25% extension to the calibration period. Although 2500 MWD/st is not explicitly addressed by References 2 through 7, Exelon's argument is reasonable given the conditions that they cite, including the smaller number of instrument failures and the better methods comparison (e.g. PANAC11 methods having a [[ ]]) which is found in Reference 7.

Reference 1 evaluated application of the change in interval within the GETAB uncertainties. However, this was revealed in the RAI questions and specifically, the response to NRC question 2, that the plant uses the improved SLMCPR methodology, commonly referred to as Reduced Uncertainties. The evaluation that Exelon performed

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is consistent with the methodology of GNF and the applicability of the bounding interval in Reference 6.

## **6. Conclusion**

The impact of an increase in the LPRM calibration to 2000 EFPH has been included in the qualification of the core monitoring system 3DMONICORE™ for PBAPS. The safety and licensing analyses are consistent with the power uncertainty of the core monitoring system, and these have been reviewed and approved by the USNRC. Therefore, operation with the LPRM calibration interval up to 2000 EFPH, which is equivalent to 2000 MWD/st core exposure at PBAPS, is justified using the existing safety evaluations as stated by the USNRC in the SER of Reference 6.

## **7. References**

1. Letter from P. B. Cowan, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, "License Amendment Request - Revise Local Power range Monitor Calibration Frequency," dated November 17, 2006
2. NEDE-20340-3, "Process Computer Performance Evaluation Accuracy", November 1985.
3. NEDE-20340-3, Rev 1, "Process Computer Performance Evaluation Accuracy", April 1986.
4. NEDE-20340-3, Rev 2, "Process Computer Performance Evaluation Accuracy", August 1991.
5. NEDE-34321, "3DMONICORE (RL3D) Performance Evaluation Accuracy", January 1994.
6. NEDC-32694P-A, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations", August 1999.
7. NEDC-32773P Rev. 1 "Advanced Methods Power Distribution Uncertainties for Core Monitoring" January 1999.
8. Letter, G. A. Watford (GNF) to R. Pulsifer (NRC), "Request for Additional Information – GE14 Review – Power Distribution Uncertainties and GEXL Correlation Development Procedure," March 27, 2001 (FLN-2001-004).